

369/44.11\*

1 WHAT IS CLAIMED IS:

2  
3 1. An optical disk reader or optical read/write system  
4 capable of operating in either a compact disk (CD) or digital  
5 versatile disk (DVD) format, comprising:

6 disk support and drive means capable of supporting and  
7 driving either a compact disk having a cover plate of thickness Y  
8 or a digital versatile disk having a cover plate of thickness X,

9 a first laser diode operating with an output beam  
10 having a first wavelength,

11 a second laser diode operating with an output beam  
12 having a second wavelength different from said first wavelength,

13 optical means for either directing the output beam of  
14 said first laser diode at a said compact disk when carried by  
15 said disk support and drive means or directing the output beam of  
16 said second laser diode at a said digital versatile disk when  
17 carried by said disk support and drive means, and

18 a single element objective lens optically positioned  
19 between said disk support and drive means on one end and said  
20 first and second laser diodes on another end,

21 said single element objective lens having a central  
22 aperture zone and an outer aperture zone, said central aperture  
23 zone being profiled to operate at a first numerical aperture (NA)  
24 and said output beam of said first laser diode being optically  
25 confined to said central aperture zone, and  
26

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1                   said single element objective lens having a central  
2 aperture zone and an outer aperture zone, said central aperture  
3 zone being profiled to operate at approximately a 0.45 numerical  
4 aperture (NA) and said output beam of said first laser diode  
5 being optically confined to said central aperture zone, and

6                   said outer aperture zone together with said central  
7 aperture zone being profiled to operate at approximately a 0.60  
8 numerical aperture (NA) and wherein said output beam of said  
9 second laser diode has ray fans extending across the full  
10 aperture of said lens.

11  
12               7. The apparatus of claim 6 wherein said first surface is  
13 located closer to said disk support and drive means than said  
14 second surface and further comprising diffractive means carried  
15 by said second surface, said diffractive means providing suf-  
16 ficient aspheric surface power for spherical aberration cor-  
17 rection and providing correction for spherochromatism.

18  
19               8. The apparatus of claim 7 wherein said diffractive  
20 means provides sufficient correction for spherical aberration and  
21 for spherochromatism that said single element objective lens  
22 achieves diffraction-limited image quality for both CD and DVD  
23 formats.

24  
25               9. The apparatus of claim 6 wherein said single element  
26 objective lens is molded cyclic olefin copolymer or PMMA.

10. The apparatus of claim 5 wherein said diffractive means has a predetermined depth to optimize diffraction efficiency for both laser diode wavelengths.

11. A single element objective lens for use in an optical disk reader or read/write system for either a CD format operating with an approximately 780 nm laser diode or a DVD format operating with an approximately 650 nm laser diode, wherein said single element lens has first and second surfaces and comprises:

a first aspheric surface defined as:

$$sag_1 = \frac{\rho_1 r^2}{1 + SQT[1 - (1 + k_1)\rho_1^2 r^2]} + A_1 r^4 + B_1 r^6 + C_1 r^8 + D_1 r^{10} \dots$$

and a second surface having an aspheric profile defined as:

$$sag_2 = \frac{\rho_2 r^2}{1 + SQT[1 - (1 + k_2)\rho_2^2 r^2]} + A_2 r^4 + B_2 r^6 + C_2 r^8 + D_2 r^{10} \dots$$

Where *sag* represents sagittal height and

|          |   |  |
|----------|---|--|
| $\rho_1$ | = | 1/radius of first surface vertex                             |
| $\rho_2$ | = | 1/radius of second surface vertex                            |
| $k_1$    | = | conic coefficient of first surface ( $-3.5 < k_1 < 0.0$ )    |
| $k_2$    | = | conic coefficient of second surface ( $-15.0 < k_2 < -5.0$ ) |

$A_1$  through  $D_1$  = general aspheric terms and are non-zero on at least one of said first or second surfaces, and  
and  
 $A_2$  through  $D_2$

the vertex curvatures  $\rho_1$  and  $\rho_2$  satisfy  $0.667 < \frac{|\rho_1|}{|\rho_2|} < 1.50$

1                   said outer aperture zone together with said central  
2 aperture zone being profiled to operate at a second numerical  
3 aperture (NA) and wherein said output beam of said second laser  
4 diode has ray fans extending across the full aperture of said  
5 lens.  
6

7  
8           2. The apparatus of claim 1 wherein said first surface is  
9 located closer to said disk support and drive means than said  
10 second surface and further comprising diffractive means carried  
11 by said second surface, said diffractive means providing suf-  
12 ficient aspheric surface power for spherical aberration cor-  
13 rection and providing correction for spherochromatism.  
14

15           3. The apparatus of claim 1 wherein said first surface is  
16 located closer to said disk support and drive means than said  
17 second surface and further comprising diffractive means carried  
18 by said first surface, said diffractive means providing suf-  
19 ficient aspheric surface power for spherical aberration cor-  
20 rection and providing correction for spherochromatism.  
21

22           4. The apparatus of claim 2 wherein said diffractive  
23 means provides sufficient correction for spherical aberration and  
24 for spherochromatism that said single element objective lens  
25 achieves diffraction-limited image quality for both CD and DVD  
26 formats.

1                   5. The apparatus of claim 1 wherein said single element  
2 objective lens is molded cyclic olefin copolymer or PMMA.  
3

4                   Sub A2 6. An optical disk reader or optical read/write system  
5 capable of operating in either a compact disk (CD) or digital  
6 versatile disk (DVD) format, comprising:  
7

8                   disk support and drive means capable of supporting and  
9 driving either a compact disk having a cover plate of thickness  
10 2X or a digital versatile disk having a cover plate of thickness  
11 X,

12                   a first laser diode operating with an output beam  
13 wavelength of approximately 780 nm,

14                   a second laser diode operating with an output beam  
15 wavelength of approximately 650 nm,

16                   optical means for either directing the output beam of  
17 said first laser diode at a said compact disk when carried by  
18 said disk support and drive means or directing the output beam of  
19 said second laser diode at a said digital versatile disk when  
20 carried by said disk support and drive means, and

21                   a single element objective lens optically positioned  
22 between said disk support and drive means on one end and said  
23 first and second laser diodes on another end, said single element  
24 objective lens having first and second surfaces, said first  
25 surface having an aspheric profile,  
26

12. A single element objective lens for use in an optical disk reader or read/write system for either a CD format operating with an approximately 780 nm laser diode or a DVD format operating with an approximately 650 nm laser diode, wherein said lens has first and second surfaces and comprises:

a first aspheric surface defined as:

$$sag_1 = \frac{\rho_1 r^2}{1 + \sqrt{1 - (1 + k_1)\rho_1^2 r^2}} + A_1 r^4 + B_1 r^6 + C_1 r^8 + D_1 r^{10} \dots$$

Where *sag* represents sagittal height and

$\rho_1$  = 1/radius of first surface vertex

$k_1$  = conic coefficient of first surface ( $-3.5 < k_1 < 0.0$ )

$A_1$  through  $D_1$  = general aspheric terms and are non-zero on at least one of said first or second surfaces, and

the vertex curvatures  $\rho_1$  and  $\rho_2$  satisfy  $0.667 < \frac{|\rho_1|}{|\rho_2|} < 1.50$

a second spherical surface including a diffractive surface with a polynomial phase function having at least the second and fourth power terms non-zero where

$$\text{Phase} = C_2 r^2 + C_4 r^4$$

and =  $0.01 < C_2 < 0.05$

and =  $0.0005 < C_4 < 0.005$